

Groundwater samples from 35 domestic wells within the shale-gas development area in Northeastern Pennsylvania

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McMahon

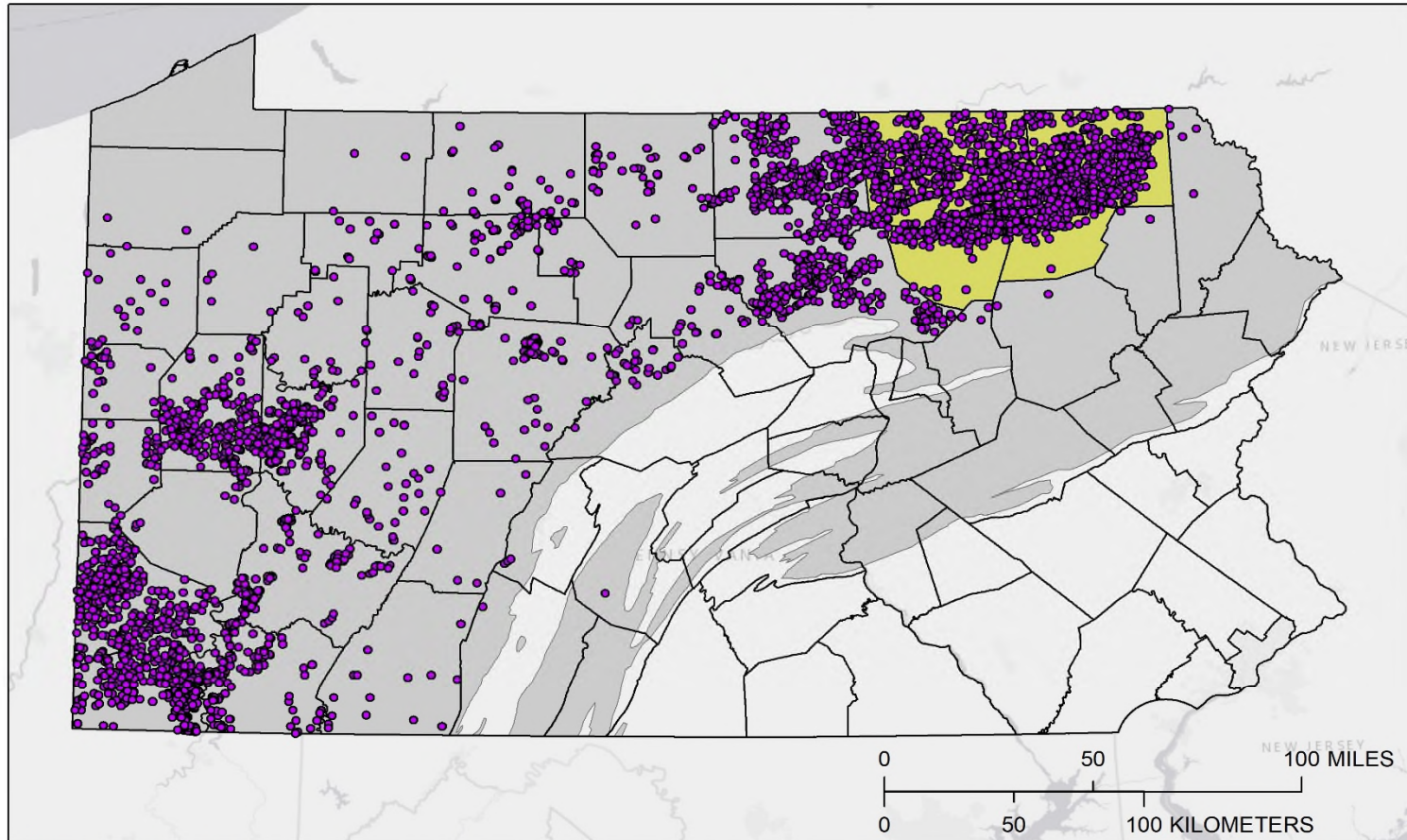
U.S. Geological Survey

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


Overview

- The National Water Quality Assessment (NAWQA) was created by Congress in 1991.
- Study units focus on specific surface water and groundwater systems.
- In 2017, a study unit was initiated to characterize groundwater in the vicinity of the Marcellus formation in Pennsylvania and New York.

Study Area



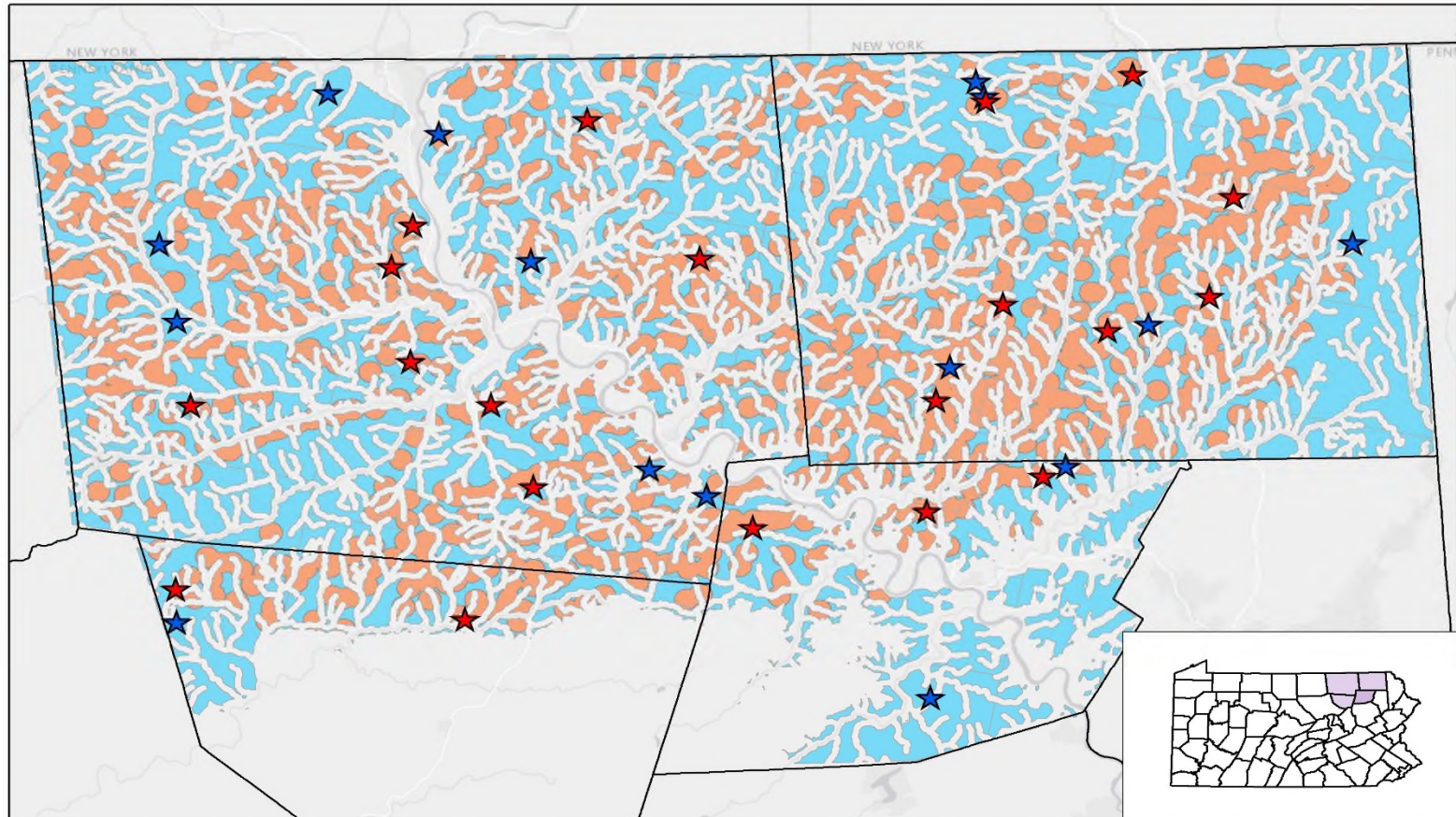
EXPLANATION

-  Extent of Marcellus Shale in Pennsylvania
-  DCNR unconventional well spud database as of March 15th, 2018
-  Study Area

Site Selection

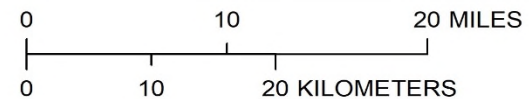
- 35 domestic wells were sampled in PA
 - 20 “Proximal” wells located $< 1,000$ meters of an active Marcellus well.
 - 15 “Distal” wells located $> 1,000$ meters of an active Marcellus well.
- All sites had to be at least 300 meters from a stream
 - Sites were at least 325 meters above sea level.

Study Location

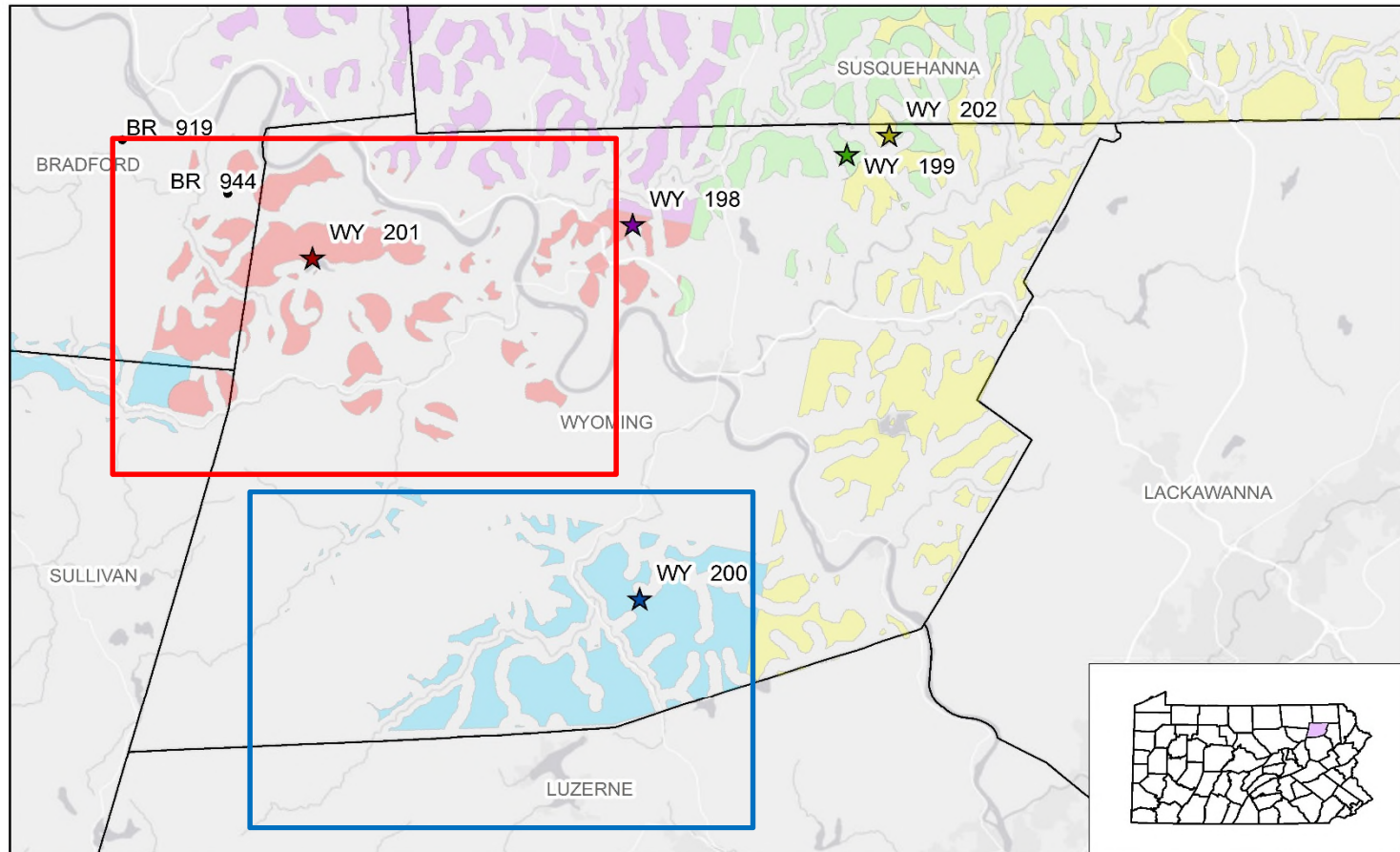


Sample Cells

- | | |
|---|--|
|  Proximal Cell |  Proximal Sites |
|  Distal Cell |  Distal Sites |

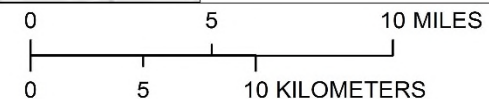


Site Selection

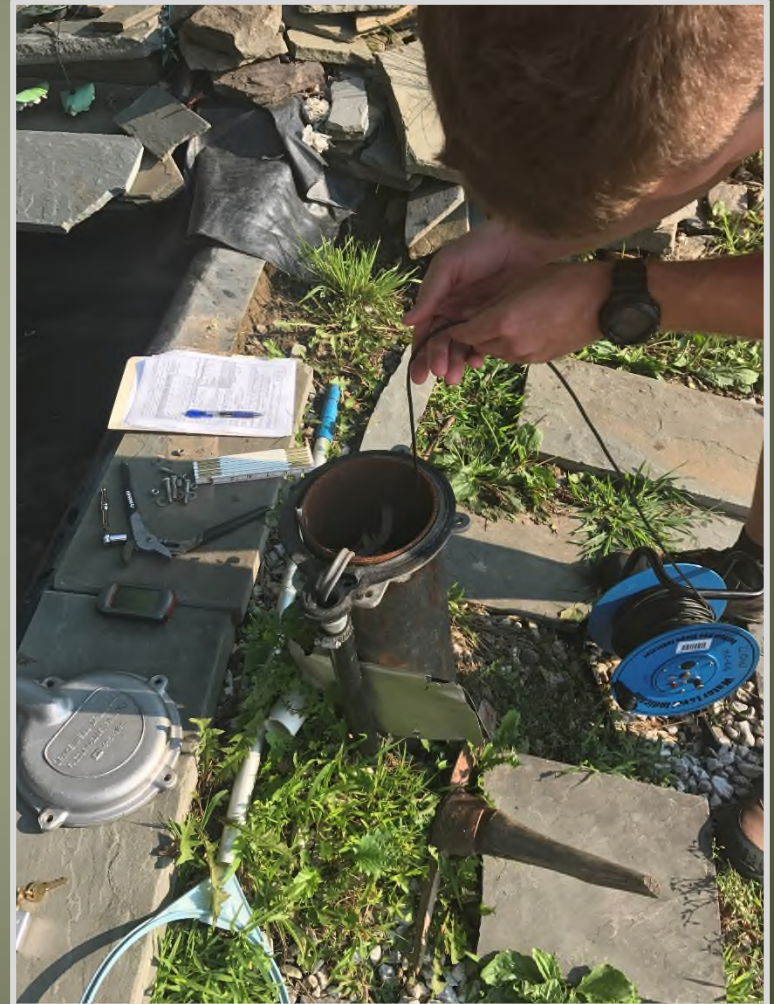


Sample Sites

- ★ WY 198 (Proximal #12)
- ★ WY 201 (Proximal #11)
- ★ WY 199 (Proximal #20)
- ★ WY 202 (Distal #15)
- ★ WY 200 (Distal #8)



Sample Procedure



Sample Procedure



Sample Procedure

- Volatile organic compounds were sampled first.
- Filtered samples
- Unfiltered samples

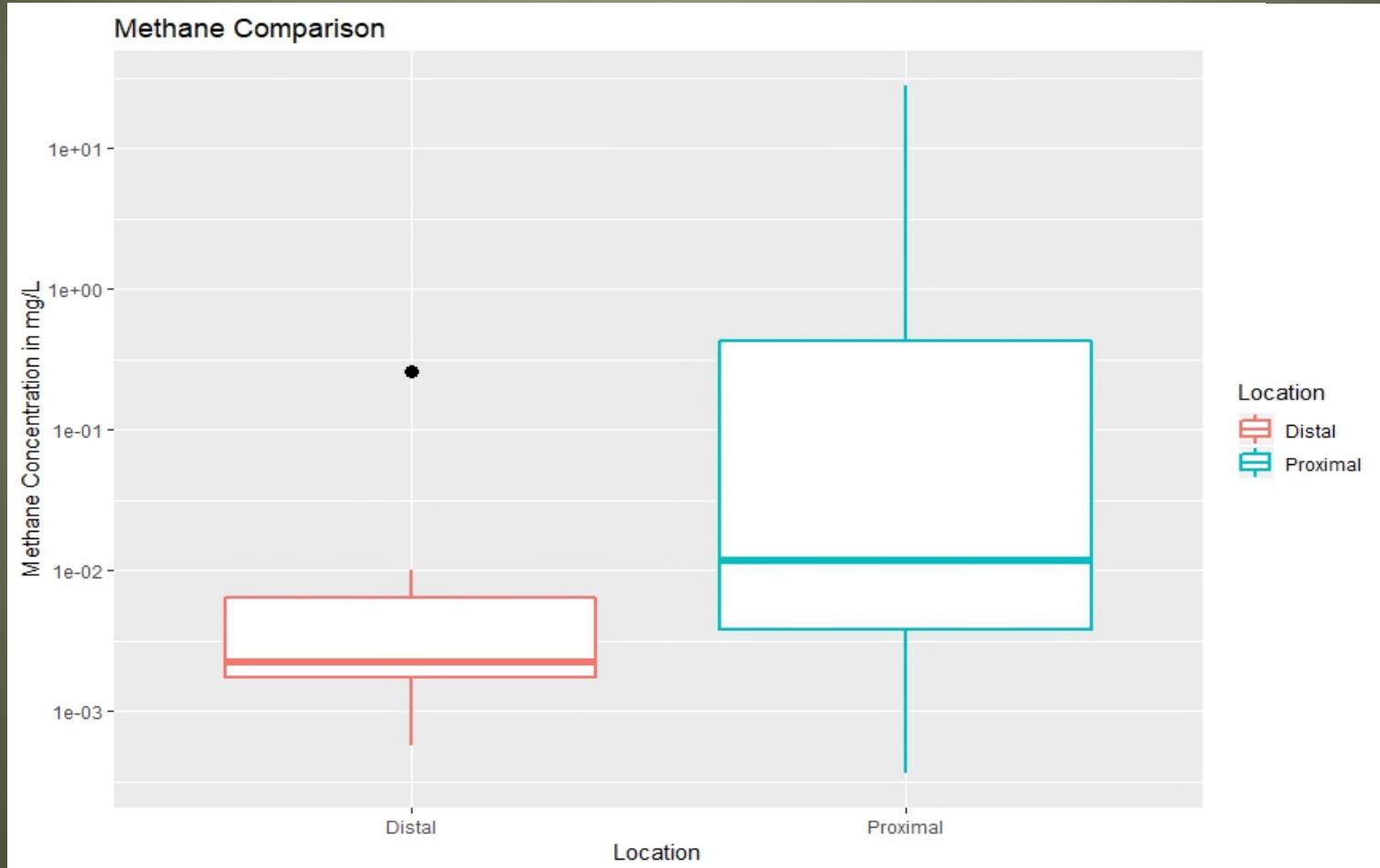


Results

- Results were screened for MCL and SMCL exceedances.
- Exceedances were reported to homeowners.
- Full reports were delivered to homeowners following the completion of data collection.

Results- Boxplots

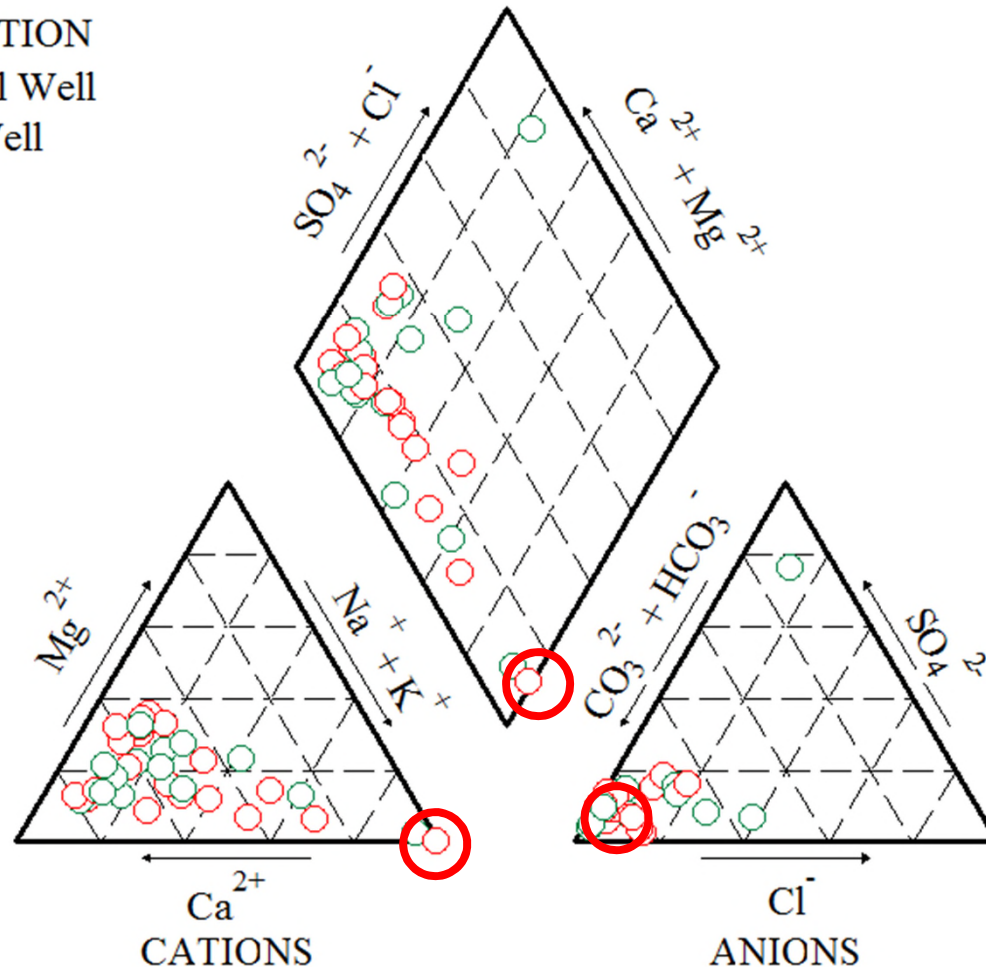
Wilcoxon Rank Sum Test, $\alpha = 0.05$



Results- Piper Diagram

EXPLANATION

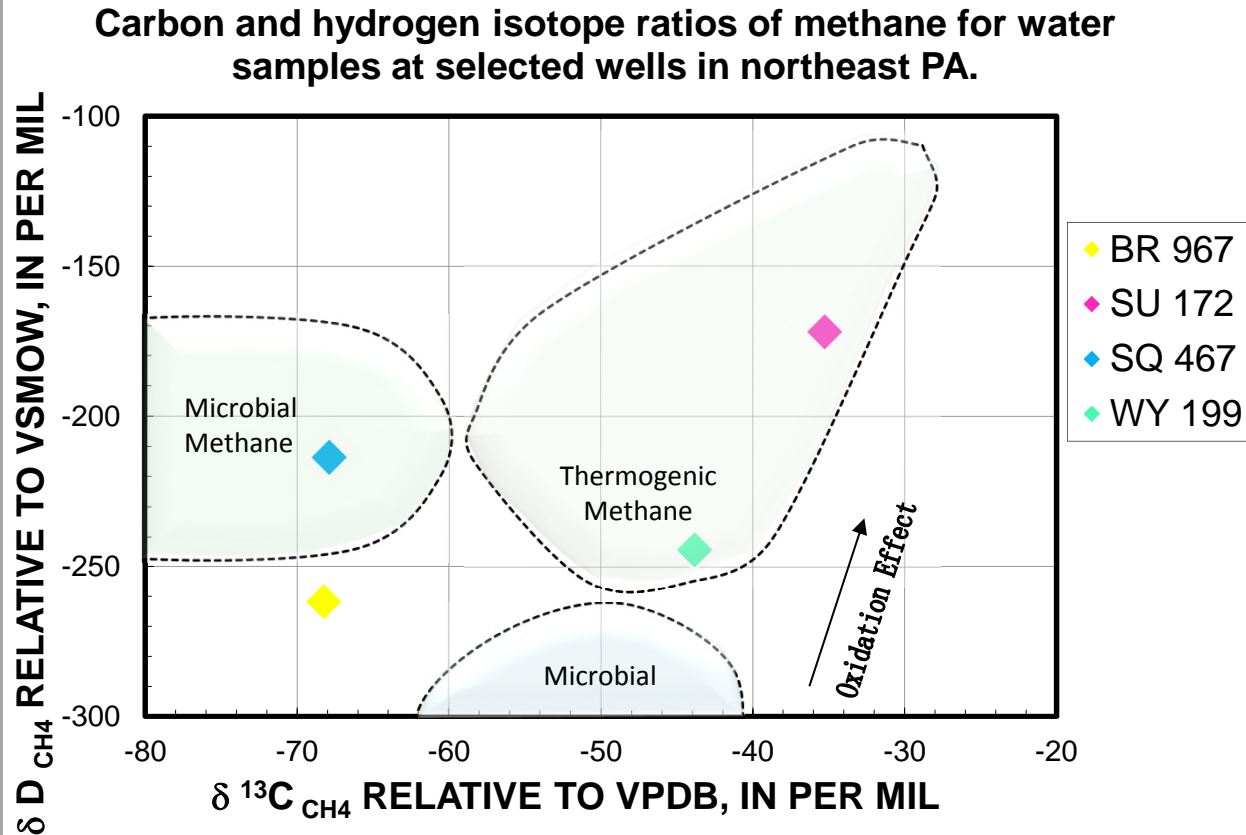
- Proximal Well
- Distal Well



Results- Exceedances

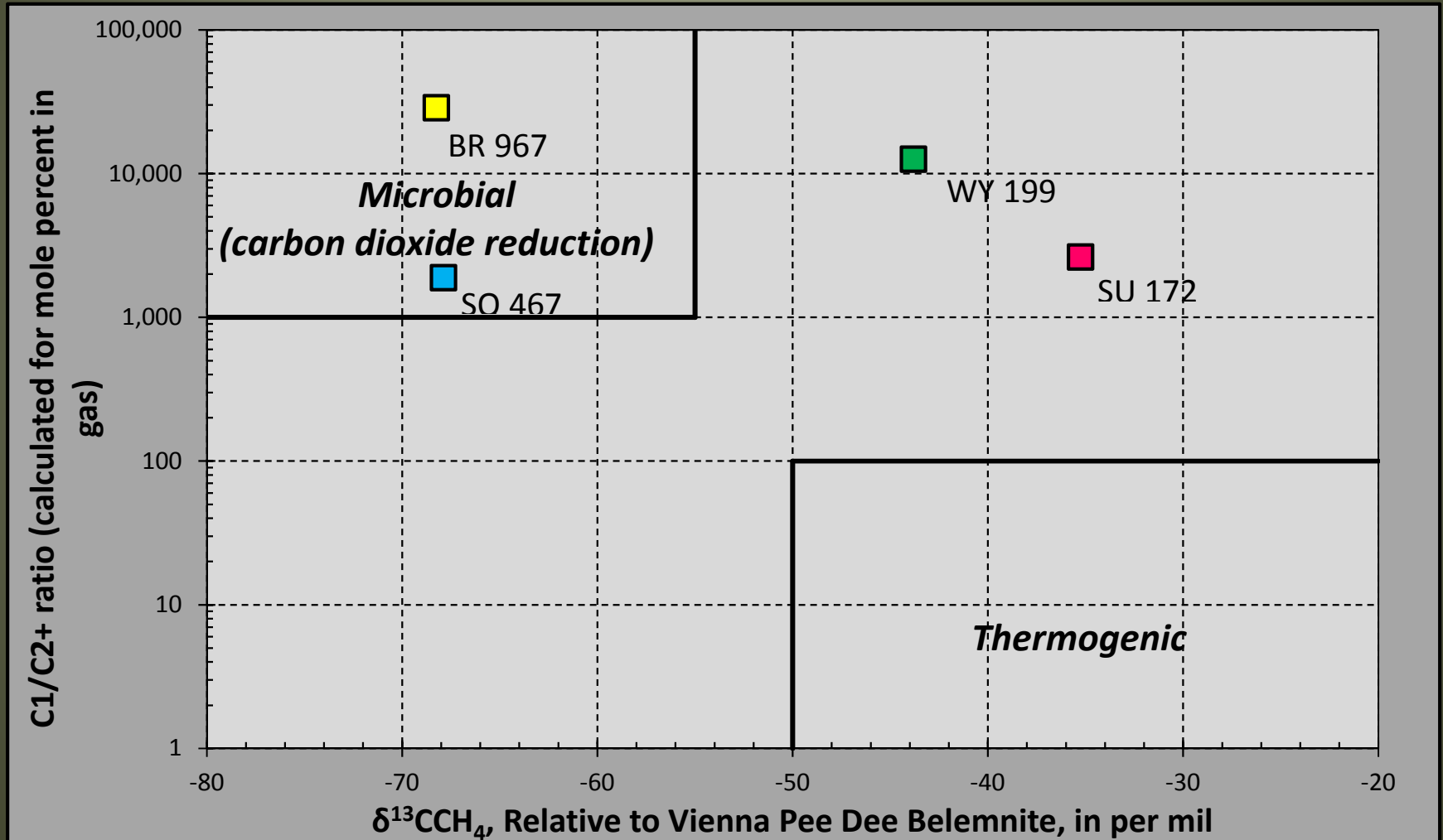
- No MCLs were exceeded.
- SMCL exceedances included fluoride (1), iron (1), manganese (7).
- OSM exceedances included methane (1).

Results- Schoell Plot

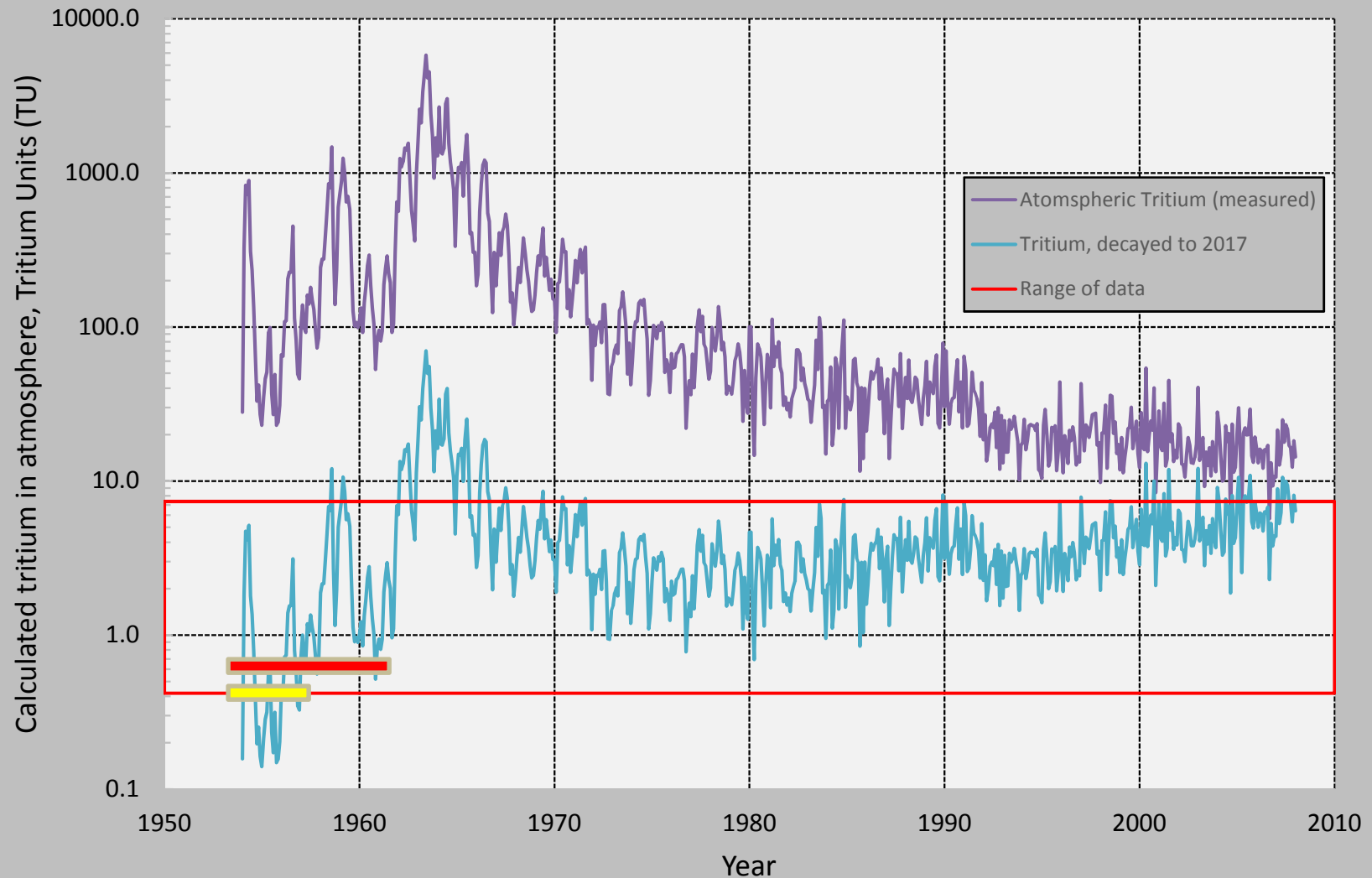


Note: Marcellus Gas region is from northcentral Pennsylvania (Baldassarre, 2011, The origin of some natural gases in Permian through Devonian Age Systems in the Appalachian Basin & the relationship to incidents of stray gas migration: EPA Technical workshops for hydraulic fracturing study, chemical and analytical methods,

Results- Bernard Plot

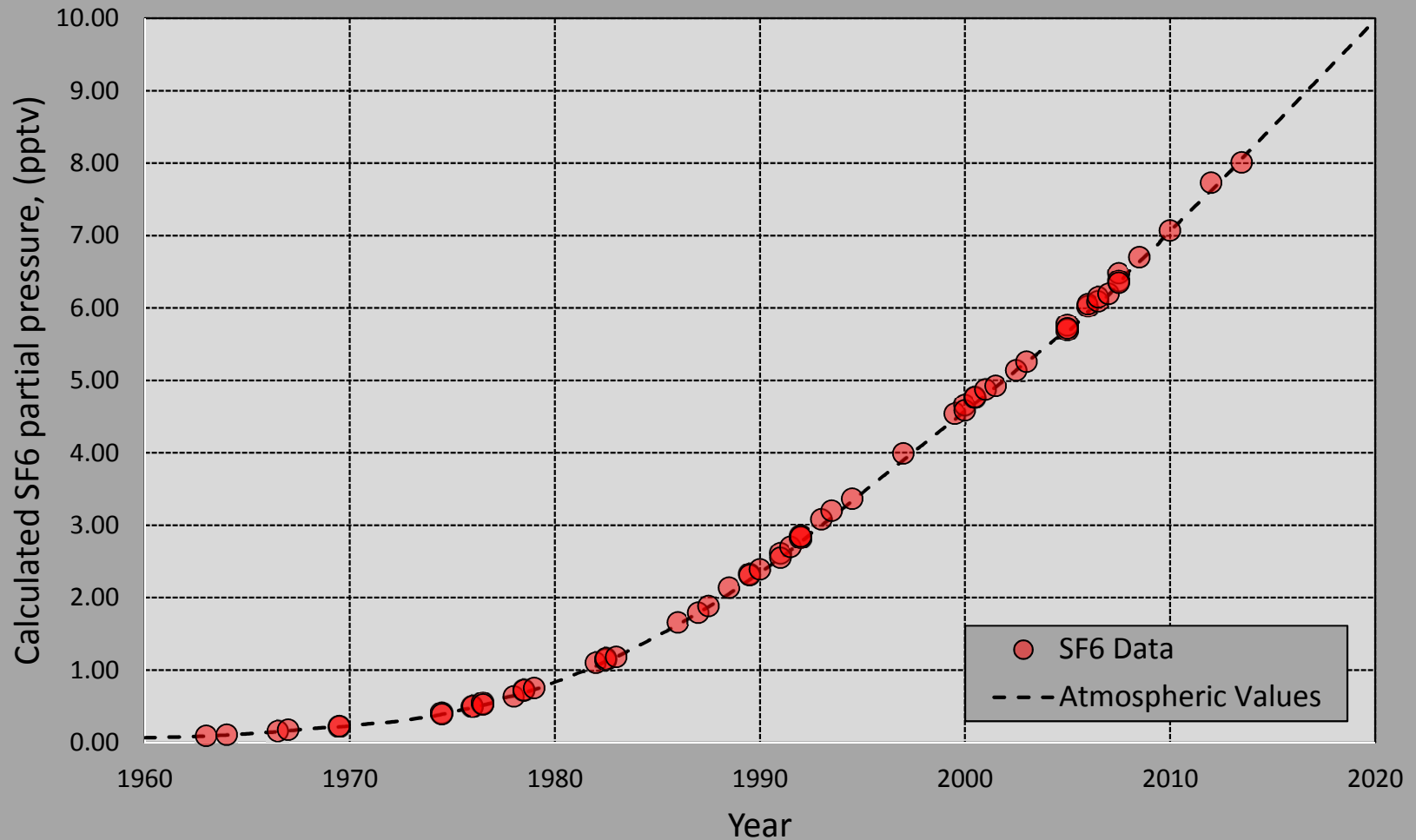


Results- Tritium



Preliminary information- Subject to revision. Not for citation or distribution

Results- SF₆ Age Dating



Preliminary information- Subject to revision. Not for citation or distribution

Additional Work

- A final report is being prepared for publication.
- A methane comparison study was sampled in 2018 and a report is in the process of being written.

Questions?

- Special thanks to Lee Eicholtz, Robin Brightbill, Kyle Ohnstad, Kenny Lambert, and Aaron Kosobucki for contributing to the sampling effort!

